[Second Edition.]

PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION.

Improvements in or relating to Manufacture of Tyres.

We, THE DUNLOP RUBBER COMPANY, LIMITED, of 14, Regent Street, Westminster, in the County of London, and COLIN MACBETH, Engineer, of the aforesaid Company's Works, Para Mills, Aston Cross, Birmingham, in the County of Warwick, do hereby declare the nature of this invention to be as follows:—

This invention relates to the manufacture of tyres, and has more particular reference to the moulding and vulcanising of pneumatic tyre covers or casings. Canvas and fabric casings are often made by the method or process known as the internal pressure system; in some internal pressure systems the casing is stretched outwardly by supplying fluid pressure to an airbag or inflatable tube within the casing so that the internal pressure caused by the expansion or inflation of the said tube stretches the tyre casing as required.

Generally stated, the advantages of the internal pressure system are as follows:—

(*a*) that it permits of fairly wide limits of accuracy in building up the casings.

(*b*) ensures that the casings are free of creases or puckers.

(*c*) ensures freedom from surface defects.

Some of the disadvantages of the internal pressure system are as follows:—

(*a*) that the casings are liable to be overstretched during vulcanisation.

(*b*) the necessity for making separate fluid pressure connections to each casing which renders difficult the use of standard autoclaves.

(*c*) when an inner inflatable tube is employed, this only lasts for a limited number of cures, and requires careful manipulation and attention to prevent early destruction.

(*d*) the cores of wired tyres require to be removed for the fitting of the raw tyre and the fitting of the inflatable tube in the mould.

(*e*) often necessitates the use of a four-piece clamped mould when the inflatable tube is employed to ensure that failure of hydraulic pressure in the autoclave will not allow the internal pressure within the tube to open the mould and damage the casing and the tube.

With this invention the use of autoclaves is not necessary and while the inflatable tube can in some cases be used yet it may be dispensed with.

According to this invention the mould shells are mounted in or form part of containers which are so constructed and arranged that an internal space is provided to which the fluid pressure can be supplied and from which the pressure is supplied to the interior of the casing. Preferably the containers are of dished or disc-like form so that the internal space is provided between the dished or disc part of the containers so as to avoid the necessity of making steam tight joints at the inner parts of the mould shells. One of the chief features of the invention consists in so arranging the interior part of the containers that it is not necessary to constantly break the fluid pressure connections leading to the interior of the casing. The mould shells are preferably adapted to be used in conjunction with a rigid core or annular ring by means of which the inner or beaded edges of the casing on the core can be clamped or secured between the two mould shells whilst

[*Price* 1*s*.]

the tread or outer part of the casing do not normally make contact with the moulding surface. For the convenience of description the term "containers" will be used to cover the case of the mould shells in one with the said disc or dished portions or the case of the mould shells detachably secured to the said portions. One container is preferably supported in a horizontal position and forms the lower container whilst the upper container may be hinged to enable it to be closed down on the lower container in which a core and casing have been placed so that the two mould shells are closed to form the mould proper. The hinged upper container can be readily opened for removal of a cured casing or the fitting of an uncured casing. The upper and lower containers may be secured together by means of bolts or other fastening devices at the outer circumference or periphery of the containers and if desired by bolts or other devices at or extending through the dished portions of the aforesaid containers. The outer engaging parts of the mould shells are suitably constructed or adapted to form steam tight joints. The core may be provided with interior passages which terminate at the outer circumferential part of the core to allow fluid pressure admitted to the core to reach the inner surface of the casing so that under the influence of internal pressure the casing is stretched at its outer or tread parts into contact with the moulding surface without being displaced at its beaded portions which as aforesaid are preferably clamped between the rigid core and the mould shells. The lower container is provided with connections through which the fluid pressure is supplied to the interior space between the two containers and in order to ensure that water or other liquid which is used only reaches the core and comes into contact with the internal surface of the casing, the lower container (preferably on the mould shell secured or attached thereto) may be provided with an up-standing internal flange or ring within and fairly close to the inner circumference of the core; the liquid pressure pipe or pipes may extend upwardly and be curved or bent over the upwardly extending flange, so that the liquid is discharged from the pipe downwardly and flows through the passages in the core to reach the internal surface of the casing. The liquid injected through the aforesaid pipe has a suitable head or pressure to ensure that all air is forced away from the internal surface of the casing. If desired a suitable vent tube or passage may be provided which extends from the outer surface of the core to the inner part thereof at its upper surface so that the air may escape through the aforesaid vent passage and thus prevent damage to the casing which is well known to occur when air under pressure is in contact with uncured rubber surfaces. The provision of this vent tube however, is rendered unnecessary in the event of the beads or inner edges of the casing fitting tightly between the core and the mould shells. An efficient sealing joint must be made between the casing edges or beads and the adjacent mould shells and this is obtained by the screwing down of the bolts or other means, which secure the containers in the closed position and also by the action of the internal pressure. Thus the casing itself forms the required steam tight joint to prevent the internal pressure from escaping or becoming diminished. In cases where the core is removed prior to the internal pressure being admitted to the interior of the casing, an annular ring may be employed which can be secured in position to retain the casing edges or beads tightly against the adjacent mould shells. This feature although perhaps entailing more handling of the uncured tyre, is advantageous in that it reduces the number of cores required and avoids the trouble due to effecting removal of the cores from the cured casing. In order to more quickly heat the mould shells to the curing temperature so as to successfully cure the casing in a short space of time, means are provided for pre-heating the water or other liquid before bringing into contact with internal surface of tyre casing and this is effected by means of a reserve container provided with a heating device such as a pipe containing steam so that when a controlling valve on the pipe leading to the mould is opened, hot water or other liquid is injected into the core by pressure supplied through a suitable connection. If desired drain valves may be provided at suitable parts in the containers for preventing accumulation of condensation therein. The containers may be provided with heating jackets for steam or other heating medium around the mould shells so as to economise in the use of steam and to more quickly impart the curing temperature to the mould shells. In a modification of this kind the mould shells are fitted in suitable grooves on the inner and opposing faces of the mould containers, which latter are provided with inwardly dished plates or diaphragms, this con-

struction of the device also reducing the steam space within the mould containers. As stated above the mould shells may be formed in one with the containers, in which case suitable steam spaces may be formed or provided in the container castings. In some cases the steam space may communicate with the interior of the casing by suitable passages so that fluid pressure may be supplied to the interior of the casing when the containers are retained in the closed position. The securing bolts at the outer parts of the container may be hinged to lugs on one of the latter, and adapted to fit to forked lugs on the other container. The lower container may be supported on a stool which may have a rearward extension to which is hinged an arm carrying the upper mould container, and a suitable counterweight or balance may be provided on the upper arm to facilitate the opening of the upper container, a hydraulic operated device may be connected to the aforesaid arm to enable the upper container to be quickly opened or closed. The containers are provided with bored attachment points in order to enable the hinge connection to be standardised and to prevent strains on the container castings.

A moulding apparatus of this kind may be situated under an overhead run way on which may travel a suitable carrier to which the core carrying the casing may be attached for placing in and removing from the lower mould shell. The aforesaid moulding apparatus may be employed in gangs or batches of four or more so that whilst one is being filled another is being emptied during which time the other moulds are in the closed position and the cure of the casings taking place. These moulds may be so positioned that a common overhead run way extends above the same. A considerable number of the moulds may be arranged in a row served by a common overhead run way, and several of such rows and run ways may be employed and when the moulds are arranged in this manner they may be staggered or arranged in such a manner that the opening of one mould will not interfere with an adjacent mould. For example, in each pair of rows the moulds may be arranged so that the upper containers open towards each other, the space between the said pairs of rows serving as a passage way for the operators. The removable mould shells are simple in construction and may be easily fitted to and removed from their containers should it be desired to change the type of tyre to be treated. The steam or water connections of the mould containers are not broken or disconnected during the removal of the tyres, thus eliminating trouble usually experienced in this respect. Internal pressure can be applied with a collapsible core in place, so that it is not necessary to remove the core from the uncured casing which is liable to be damaged by such removal. As stated aforesaid the use of an internal inflatable tube can be dispensed with, as the mould shells and the casing together constitute the internal pressure container.

Dated this 2nd day of April, 1919.

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Agents for the Applicants.

COMPLETE SPECIFICATION.

Improvements in or relating to Manufacture of Tyres.

We, THE DUNLOP RUBBER COMPANY, LIMITED, of 14, Regent Street, Westminster, in the County of London, and COLIN MACBETH, Chief Engineer, of the aforesaid Company's Works, Para Mills, Aston Cross, Birmingham, in the County of Warwick, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the manufacture of tyres, and has more particular reference to the moulding and vulcanising of pneumatic tyre covers or casings. Canvas and fabric casings are often made by the method or process known as the internal pressure system in which fluid pressure is admitted to the interior of the casing whilst held in arched form in a mould so that the pressure within the casing stretches the casing at its outer or tread part into contact with the moulding surfaces. In some internal pressure systems the casing is stretched outwardly by supplying fluid pressure to an inflatable bag or tube within the casing so that the internal pressure caused by the expansion

or inflation of the said tube stretches the tyre casing as required.

According to this invention the mould shells are associated with suitable portions which close the circular space within the inner circumferential edges of the mould shells so that an internal space is provided between the said portions to which internal space fluid pressure can be supplied and from which the pressure can be supplied to the interior of the casing and/or to jackets or spaces in the mould shells in close proximity to the moulding space formed between the mould shells. The mould shells may be mounted in or may form part of dished or disc-like containers so that the internal space is provided between the dished or disc parts of the containers so as to avoid the necessity of making steam tight joints at the inner parts of the mould shells. One of the chief features of the invention consists in so arranging the interior parts of the containers that it is not necessary to break or disconnect the fluid pressure connections after each cure. The mould shells may be adapted to be used in conjunction with a rigid core or annular ring by means of which the inner or beaded edges of the casing on the core can be clamped or secured between the two mould shells whilst the tread or outer part of the casing does not make contact with the moulding surface, until the fluid pressure is supplied to the interior casing. For convenience of description the term "containers" will be used to cover the case of the mould shells formed in one therewith and the case of the mould shells detachably secured thereto. One container is preferably supported in a horizontal position and forms the lower container whilst the upper container may be hinged to enable it to be closed down on the lower container and the means for supplying the fluid pressure are connected to the lower container.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be described more fully with reference to the accompanying drawings, in which :—

Figure 1 is a diagrammatic sectional view showing upper and lower mould shells secured to disc-like containers.

Figure 2 is a fragmentary sectional view showing, on an enlarged scale, a core and tyre casing fitted in the mould shells and the pipe connections for supplying the fluid pressure.

Figures 3, 4, 5, 6, and 7 are somewhat similar views to Figure 2 (drawn to a smaller scale) showing modifications.

Figure 8 is an elevation of one construction of the complete mould showing a fixed lower container and a hinged upper container.

Figure 9 is a diagrammatic view illustrating one arrangement of the complete moulds such as shown in Figure 8.

A and B represent the upper and lower mould shells respectively. C and D represent respectively the upper and lower containers for the mould shells which may be secured in or to the containers by screws or bolts such as E as indicated for example in Figures 1 and 2. The mould shells may however be secured in the containers in any appropriate manner or they may be formed in one therewith as shown in Figures 4 and 5. In most of the examples shown the containers C, D are of disc form so that an interior space F is provided by the two diaphragm or central parts C^1, D^1 of the containers within the inner circumferential edges of the mould shells as diagrammatically shown in Figure 1. The space F may constitute a chamber for steam or other fluid supplied through a connection H secured to the lower container which is usually a fixture and this space may be in communication with jackets or spaces I around the mould shells ; the interior space F also avoids the necessity of making fluid tight joints at the inner circumference of the mould shells. The lower container may be fixed on any suitable form of support as shown at D^2 in Figure 2, or it may be mounted on the base or support D^2 shown in Figures 8 and 9. In the example shown in Figure 8 the upper container C carrying the upper mould shell A is preferably hingedly mounted on a pin J by means of an arm C^2 extending from the container C, the pin J being mounted in an extension D^3 of the support D^2. Hydraulic means such as a piston K in a cylinder K^1 may be provided so that the admission of water to the upper or lower side of the piston through pipes K^2 K^3 will move the piston which through a rod K^4 and link K^5 will effect the raising of the upper container to the open position or the lowering of the container to the closed position : a balance weight K^6 may also be secured to the arm of the upper container to assist in the opening movement of the latter. When the upper container with its mould shell is in the raised or opened position a tyre casing L on a core L^1 can be placed in the lower mould shell B and the upper container C is then lowered to bring its mould shell A into the closed position on the lower mould shell to embrace the cas-

ing L and the core L^1 as shown in Figure 2. The upper and lower containers are then secured in the closed position by means of bolts M or other means at the outer circumference of the containers and if desired by bolts M^1 or other means, extending through suitable bosses on the container disposed within the inner circumference of the mould shells, see Figure 2. Packing rings M^2 are provided between the mould shells and the containers to make fluid tight joints and effect a proper closure for the heating spaces I. The core L^1 may be collapsible or otherwise as may be required to suit wired or soft beaded casings. The core may also be solid or hollow. The tyre casing is built up to such size that at its outer or tread part it does not completely fill the moulding space formed between the two mould shells, so that by means of internal pressure within the casing, the latter can be stretched or expanded to contact with the mould shells, the casing being shown in its expanded position in Figures 2 to 8. For the purpose of supplying fluid pressure to the interior of the casing the core L^1 is provided with a passage or pipe L^2 in communication with the space F between the containers and leading to the outer surface of the core so that fluid pressure can reach the interior surface of the outer part and if desired the sides of the casing and thus expand or stretch the casing into contact with the inner surfaces of the mould shells without displacing the casing at its beads or wired edges which are clamped between the core and the mould shells as shown. Owing to the pipe or passage L^2 leading to the outer surface of the core it prevents air inside a hollow core (see Figure 3, 4 and 6) from coming into contact with the inner surface of the casing, thus preventing damage which is caused by air pressure on the uncured rubberised surface of the casing. One construction of means for admitting fluid pressure to the interior of the containers is shown in Figure 2 wherein the pipe H extending through the lower container is bent over at its upper end to discharge the fluid into a space between the inner core and an upstanding flange B^1, preferably formed in one with the lower mould shell in order to ensure that the fluid reaches the interior of the core and effects the expansion or stretching of the casing.

In order to prevent steam contacting with the interior surface of the tyre casing hot water may be injected from a reserve container H^1 having a heating device such as a steam pipe H^2 and when the valve H^3 is opened the water is forced from the container H^1 by pressure entering through the pipe H^4. When this arrangement is employed the hot water is injected until it overflows the upstanding flange B^1 whereupon hot water is shut off and steam admitted to commence the cure. This system may be used to ensure driving air out from between the core and casing and for this purpose the air may escape through the vent tube or passage L^4 when the hot water is admitted. It is very desirable to make a proper closure between the beads or edges of the casing and the mould shells, and such proper closure may be obtained by the screwing down of the securing bolts M^1 or other means and also by the action of the internal pressure. The casing itself forms the required fluid tight joint to prevent the internal pressure from escaping or diminishing. If desired drain pipes and valves M^4 may be provided at suitable parts of the containers to prevent accumulation of condensation in the containers. Owing to the provision of the steam or heating spaces around the mould shells and the access of the steam or other heating medium thereto from the space F between the containers, the curing temperature can be quickly imparted to the moulds.

Instead of using a complete core such as L^1 a ring L^3 see Figure 5 may be provided which serves to clamp and retain just the edges of the casing against the mould shells, this ring having a steam or fluid pressure pipe L^5 leading to the interior of the casing.

The example shown in Figure 7 illustrates a bag or tube L^7 within the casing; the bag or tube may be provided with a valve or pipe L^8 passing through a core ring L^9 for enabling fluid pressure to be admitted to the interior of the tube for expanding or forcing the outer part of the casing into contact with the mould shells. In order to prevent ingress of air between the tube L^7 and the casing the pipe L^8 secured to the tube is adapted to be pulled against the core ring L^9, for example, by screwing up a nut threaded on the pipe against the inner surface of the core ring. Preferably the use of the air bag is avoided and the fluid is permitted to come into direct contact with the inner surface of the casing. In order to prevent the pressure medium from penetrating the casing, the inner surface may be coated with a thick layer of rubber solution, for example it may be brushed with a cold cure solution: or the inner ply or plies of the casing may be made of semi-

cured rubberised fabric. The above description sets forth the general features of construction of the apparatus. Figures 3, 4, 5 and 6 illustrate modifications in which the parts corresponding to those shown in Figure 2 are designated by similar reference letters. In Figure 3 the mould shells A and B are fitted in grooves formed in the containers and steam or heating spaces I are provided around the said grooves for heating the mould shells, which spaces may be supplied with the heating medium from the space F between the containers or from an independent source, preferably from an independent source so as to economise in the consumption of steam due to the heating spaces or jackets always being connected to the steam supply and not exhausted after each cure. In this example and also that shown in Figure 5 the central or disc portions C^1 and D^1 of the containers are inwardly dished to reduce the size of the steam space F between them. The modifications shown in Figures 4 and 5 show the mould shells A and B formed in one with the containers C, D in such manner as to provide the heating spaces around or in proximity to the portions forming the upper and lower mould shells.

The construction of the containers with removable mould shells is advantageous as the latter may be readily removed and substituted by others to take a different size or type of tyre thereby enabling the same moulding apparatus to be used for various types of tyres. The steam or water connections are not disconnected from the apparatus during removal of the casings from the mould shells after curing as they are connected to the lower container which is not moved when the upper one is raised, thus eliminating trouble usually experienced in this respect. Internal pressure can be applied with a collapsible core in place so that it is not necessary to remove the uncured casing therefrom which is liable to be damaged by such removal. As stated above the use of an internal inflatable air tube or bag can be avoided as the mould shells and the casing constitute the internal pressure receiver. The construction of the moulding apparatus shown in the drawings present many advantages and also permits of the handling of tyre cores *etc.*, being facilitated and expedited with a minimum of labour and little effort on the part of the operators. The moulds may be placed under an overhead rail or runway along which may travel a carrier from which a core with casing thereon can be suspended either when placing in or when removing from the mould. The moulds may be arranged in gangs or batches so that whilst one (or others) are being emptied another (or others) can be filled during which operations the other moulds are closed and the cure of casings taking place. An overhead runway would serve for the several moulds so arranged. A considerable number of moulds may be arranged in a row served by a common overhead rail or runway and several of such rows with an overhead runway N for each row may be employed as shown in Figure 9 and when the moulds are arranged in this manner they may be staggered or otherwise positioned so that the opening of one mould will not interfere with the adjacent mould. As shown in Figure 9 the moulds in each pair of rows may be arranged back to back so that the upper containers move towards each other when opening, the space between each pair of rows serving as a gangway or passage for the operators.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is :—

1. Apparatus for moulding and vulcanising tyre casings and the like in which mould shells that receive the casing or the like are associated with suitable portions which close the circular space within the inner circumferential edges of the mould shells so that an internal space is provided between the said portions to which internal space fluid pressure may be supplied and from which the pressure may be supplied to the interior of the casing and the like and/or to jackets or spaces in the mould shells in close proximity to the moulding space between the mould shells, substantially as and for the purpose specified.

2. Apparatus for moulding and vulcanising tyre casings and the like in which the mould shells are mounted in or form part of disc-like containers, the space between the central portions of which constitutes a chamber to which fluid pressure is supplied and which is in communication with the interior of the mould shells, substantially as and for the purpose specified.

3. Apparatus as set forth in Claim 2 in which the said chamber is also in communication with heating chambers or spaces around the mould shells, substantially as and for the purpose specified.

4. Apparatus as set forth in Claim 2 in which the mould shells are provided with heating jackets or spaces to which steam is supplied from a connection which is separate from that leading to the chamber formed between the containers, substantially as and for the purpose specified.

5. Apparatus as set forth in any of the preceding claims in which the containers are arranged horizontally, the lower one of which is fixed and the upper one is movably mounted substantially as and for the purpose specified.

6. Apparatus as set forth in Claim 5 in which the fluid pressure connections are secured to the lower container substantially as described for the purpose specified.

7. Apparatus as set forth in any of the preceding claims in which a flange or similar part extends around the inner surface of the core or core ring in the tyre casing to form a chamber or channel into which fluid pressure can be introduced at the upper part thereof and from which it passes to the interior space within the tyre casing, substantially as and for the purpose specified.

8. Apparatus as set forth in any of the preceding claims in which means are provided for ensuring expulsion of air from the interior space within the tyre casing, substantially as and for the purpose specified.

9. In the manufacture of pneumatic tyre casings by apparatus as set forth in any of the preceding claims, preventing the steam from coming into contact with or from penetrating the inner surface or plies of the tyre casing, substantially as hereinbefore described for the purpose specified.

10. A plant comprising several moulding and vulcanising apparatus as set forth in any of the preceding claims, the apparatus being arranged in rows each of which latter is served by an overhead runway substantially as described for the purpose specified.

11. Apparatus for moulding and vulcanising tyres having its parts constructed, arranged and adapted to operate substantially as hereinbefore described with reference to any of the examples shown in the accompanying drawings for the purpose specified.

Dated this 3rd day of November, 1919.

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2nd Edition

Fig. 1.

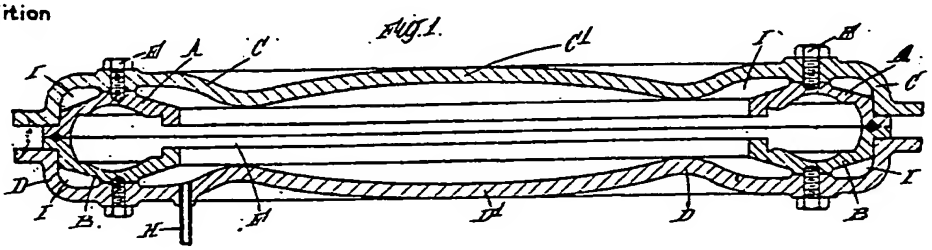

Fig. 2.

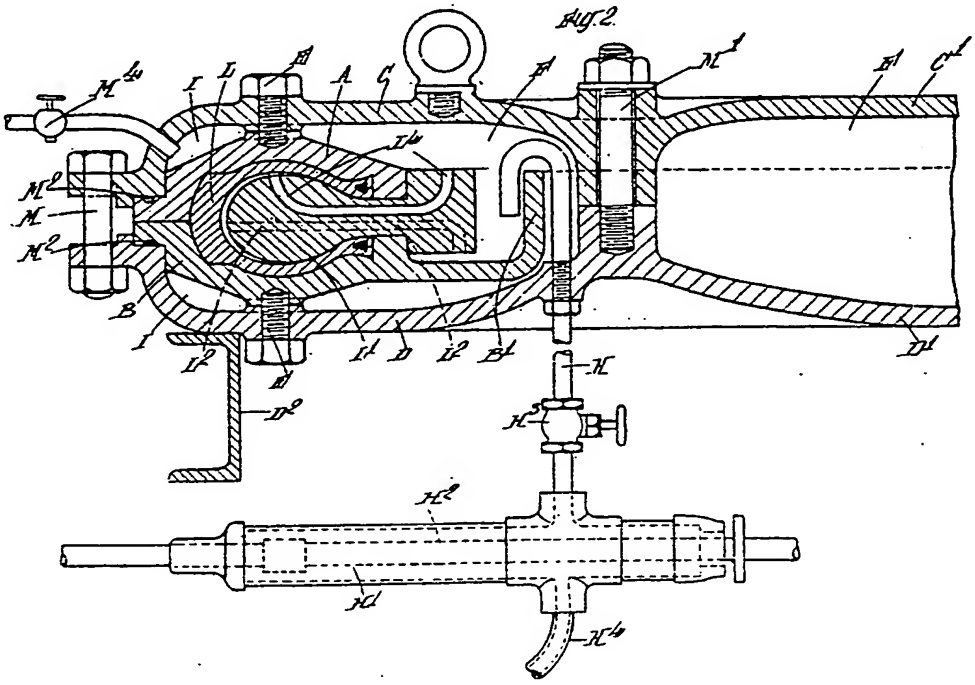

Fig. 3.

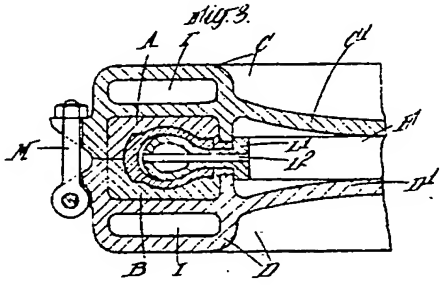

Fig. 4.

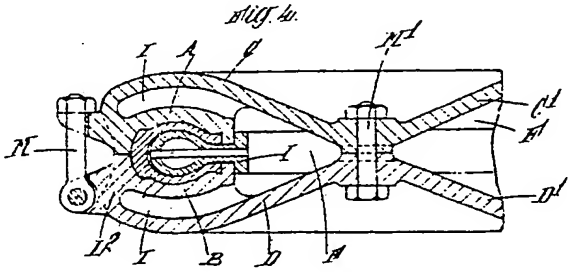

Fig. 5.

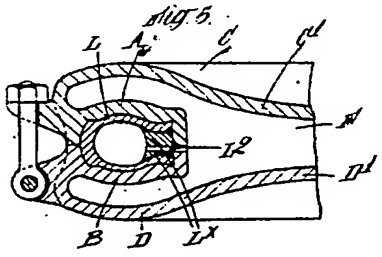

Fig. 6.